C3102

Log Data Report

Borehole Information:

Borehole: C3102			Site: 216-T-26		
Coordinates		GWL (ft)[1]:	225.72	GWL Date:	07/20/01
North	East	Drill Date	TOC[2] Elevation	Total Depth (ft)	Type
N/A[3]	N/A	06/01	not available	227.0	cable tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inner Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
steel threaded	0.75	11.75	10.25	0.75	0	59
	1.23	8.625	7.625	0.50	0	101
	1.75	6.625	5.625	0.50	0	224.8

Borehole Notes:

This is a temporary borehole drilled to a depth of approximately 227 ft. A gravel pad approximately 1.5 to 2 ft thick is placed over the previous ground surface. The zero foot reference point for the log data is the top of the gravel surface. Casing depths and groundwater depth were provided by the driller.

Logging Equipment Information:

Logging System:	Gamma 2B	Type:	SGLS (35%)
Calibration Date:	09/00	Calibration Reference:	09/00
		Logging Procedure:	MAC-HGLP 1.6.5
Logging System:	Gamma 2C	Type:	NMLS (Moisture)
Calibration Date:	06/01	Calibration Reference:	05/01
		Logging Procedure:	MAC-HGLP 1.6.5

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4	(5) Repeat
Date	06/29/01	06/29/01	06/29/01	06/29/01	06/29/01
Logging Engineer	Musial	Musial	Musial	Musial	Musial
Start Depth (ft)	0.00	18.50	19.00	21.52	22.01
Finish Depth (ft)	17.00	18.50	21.00	60.02	27.01
Count Time (sec)	200	200	30	200	30
Live/Real	L	R	L	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	0.5	0.5	0.5	0.5	0.5
ft/min	n/a	n/a	n/a	n/a	n/a
Pre-Verification	B0011CAB	B0011CAB	B0011CAB	B0011CAB	B0011CAB
Start File	B0011000	B0011035	B0011036	B0011041	B0011123
Finish File	B0011034	B0011035	B0011040	B0011122	B0011133
Post-Verification	Spectrum lost due to operator error				

Log Run	6	7 (Repeat)	8	9	10 (Repeat)
Date	07/03/01	07/03/01	07/19/01	07/19/01	07/20/01
Logging Engineer	Musial/Spatz	Musial/Spatz	Musial/Kos	Kos	Kos
Start Depth (ft)	59.00	97.00	100.00	175.00	16.00
Finish Depth (ft)	101.01	93.00	175.00	226.10	23.52
Count Time (sec)	200	200	200	200	200
Live/Real	L	L	L	L	R/L
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	0.5	0.5	0.5	0.5	0.5
ft/min	n/a	n/a	n/a	n/a	n/a
Pre-Verification	B0013CAB	B0013CAB	B0020CAB	B0020CAB	B0020CAB
Start File	B0013000	B0016106	B0020000	B0020151	B0020255
Finish File	B0013084	B0016120	B0020150	B0020254	B0020270
Post-Verification	B0013CAA	B0013CAA	B0020CAA	B0020CAA	B0020CAA

Log Run	11 (Repeat)				
Date	07/20/01				
Logging Engineer	Kos				
Start Depth (ft)	32.00				
Finish Depth (ft)	23.52				
Count Time (sec)	200				
Live/Real	R				
Shield (Y/N)	N				
MSA Interval (ft)	0.5				
ft/min	n/a				
Pre-Verification	B0020CAB				
Start File	B0020271				
Finish File	B0020281				
Post-Verification	B0020CAA				

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	12 Moisture	13 M-repeat	14 Moisture	15 Moisture	
Date	07/03/01	07/03/01	07/20/01	07/20/01	
Logging Engineer	Musial/Spatz	Musial/Spatz	Spatz	Spatz	
Start Depth (ft)	59.00	85.00	99.00	187.00	
Finish Depth (ft)	101.00	80.00	200.00	224.00	
Count Time (sec)	n/a	n/a	n/a	n/a	
Live/Real	n/a	n/a	n/a	n/a	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	n/a	n/a	n/a	n/a	
ft/min	1	1	1	1	
Pre-Verification	C0000CAB	C0000CAB	C0001CAB	C0001CAB	
Start File	C0000000	C0000169	C0001000	C0001405	
Finish File	C0000168	C0000189	C0001404	C0001457	
Post-Verification	C0000CAA	C0000CAA	C0001CAA	C0001CAA	

Logging Operation Notes:

Logging occurred on four separate days in three different casing configurations as the borehole was drilled. Logging was optimized so that data were collected in only a single casing thickness. Multiple log runs were made to adjust counting times in response to high dead time intervals and to perform repeat logging. In areas of excessive dead time, the count time was reduced to 30 sec to provide a log record where spectra were not anticipated to contain reliable energy peaks. Data overlaps of 1 ft were collected during

successive log runs. The post-run verification spectrum file for 6/29/01 (B0011CAA) was lost due to operator error.

Analysis Notes:

Analyst:	Henwood	Date:	07/27/01	Reference:	

Pre-run and post-run verification of the logging tool were performed for each day's log event. The post-run verification for log runs 1-5 conducted June 29, 2001 was not available for processing. The post-run verification for log runs 6 and 7 failed the acceptance criteria: the peak counts per second for the 2614.5 keV peak was below the control limit. Examination of the spectrum indicates the detector appears to be functioning normally and the log data are provisionally accepted. The pre-verification spectra met the acceptance criteria for data collected during log runs 1-7 and were used for the energy and resolution calibration to process the data. The pre- and post-verification spectra collected for log runs 8 and 9 were acceptable. Repeat log data (log runs 10 and 11) are not analyzed and reported because these log runs occurred in a triple casing configuration where the total thickness of the casing was about 1.75 in. This casing configuration is beyond the range of the casing correction function. Log runs 12-15 record moisture data.

Each spectrum collected during a log run was processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated from peak count rates using EXCEL to apply the inverse efficiency function and corrections for dead time and casing thickness. In zones of high dead time (> 40 %), maximum gross count rates and radionuclide concentrations are not considered reliable, and may be significantly higher than reported values, particularly as the dead time approaches 100 percent where detector saturation typically occurs and no data are collected. Where dead time is greater than about 40 percent, pulse pileup and peak spreading effects tend to result in underestimation of peak count rates. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations rather than the ^{214}Bi peak at 609 keV. The 609 keV peak cannot be distinguished as a result of interference from the ^{137}Cs peak at 662 keV in higher concentration zones.

For the neutron moisture log, calibration functions are available for 6-in. and 8-in.-diameter holes with conventional ASTM Schedule 40 steel casing. The calibration function converts total neutron count rate to volume percent moisture content. Neutron moisture data from the interval between 59 and 101 ft were analyzed using the calibration function for an 8-in. borehole. Neutron moisture data from the interval between 99 and 224 ft were analyzed using the calibration function for a 6-in. borehole. A correction factor developed from data provided by Meisner, Price, and Randall (WHC-SD-EN-TI-306) was applied to the data in the 8-in. interval to account for the 0.5-in. casing thickness. This factor increased the calculated moisture content by approximately 20 percent. No such correction factor was available for a 6-in. borehole; therefore, the same correction factor was also applied over this interval.

The data overlaps collected during successive logging runs were not processed. The 1-ft overlaps were collected in a double-casing configuration such that the total thickness of two casings exceeded the range of available casing corrections.

Log Plot Notes:

Separate log plots are provided for man-made radionuclides (^{137}Cs, ^{154}Eu, and ^{60}Co), naturally occurring radionuclides (^{40}K, ^{232}Th, ^{238}U [KUT], and associated decay progeny), a combination of man-made, KUT, dead time, and moisture, repeat logs, and a plot of the total gamma. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable limit (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing and water corrections. These errors are discussed in the calibration report.

In order to provide a common reference point, the depths for all log runs were normalized to ground surface. Log runs 6 and 7 were depth adjusted downward 1.23 ft to account for a depth initialization at the top of casing at the time of logging. The other spectral gamma log runs were initialized at ground surface. The moisture log data in log runs 12 and 13 were also corrected 1.23 ft downward. In addition, a downward offset of 0.5 ft (total 1.73 ft) was added to the moisture data in log runs 12 and 13 to account for a discrepancy where the depth offset entered in the logging computer reflected the offset for the spectral gamma logging tool detector rather than the depth offset for the neutron detector. This discrepancy was corrected in subsequent logging runs.

On the combination plot, intervals where dead time exceeds 40 percent are shaded. Concentrations of all radionuclides in these depth intervals may be underestimated slightly, the degree of underestimation increasing as 100 percent dead time is approached. Also on the combination plot, the gross gamma data have been plotted at both log and linear scales. The log scale shows detail in the contaminated intervals, where gross count rates may vary over several orders of magnitude. The linear scale shows detail in uncontaminated intervals, where subtle variations in gamma activity may be an indication of stratigraphic changes.

Repeat log plots at selected depth intervals for man-made and KUT concentrations and moisture measurements are also included. The repeat plots indicate good agreement between successive log runs, demonstrating repeatability in both depth and concentration measurement.

Results and Interpretations:

The man-made radionuclides ^{137}Cs, ^{154}Eu, and ^{60}Co were detected in this borehole. ^{137}Cs is detected almost continuously from the ground surface to about 60 ft in depth with the highest ^{137}Cs concentrations greater than 3,000 pCi/g occurring at about 19 and 35 ft in depth. ^{154}Eu is detected at about 35 and 52 ft with a maximum concentration that exceeds 10 pCi/g. ^{60}Co is detected intermittently at depths between 90 and 135 ft at low concentrations (i.e., less than 0.2 pCi/g). The ^{60}Co appears to be generally associated with zones of higher moisture content as indicated by the neutron moisture log.

On the basis of low ^{40}K concentrations, the carbonate rich paleosols of the Pliocene-Pleistocene are interpreted as lying between 99 and 116 ft. A caliche layer with characteristically high naturally occurring ^{238}U and low ^{40}K concentrations is observed at about 114 ft. The interval between 90 and 100 ft is interpreted, on the basis of relatively high ^{232}Th concentrations, to consist of the early Palouse soil, a silty sand to sandy silt. The combined carbonate-rich soils and the early Palouse soils separate the Ringold formation (116 ft) from the Hanford formation that ends at about 90 ft.

[1] GWL – groundwater level
[2] TOC – top of casing
[3] N/A – not applicable

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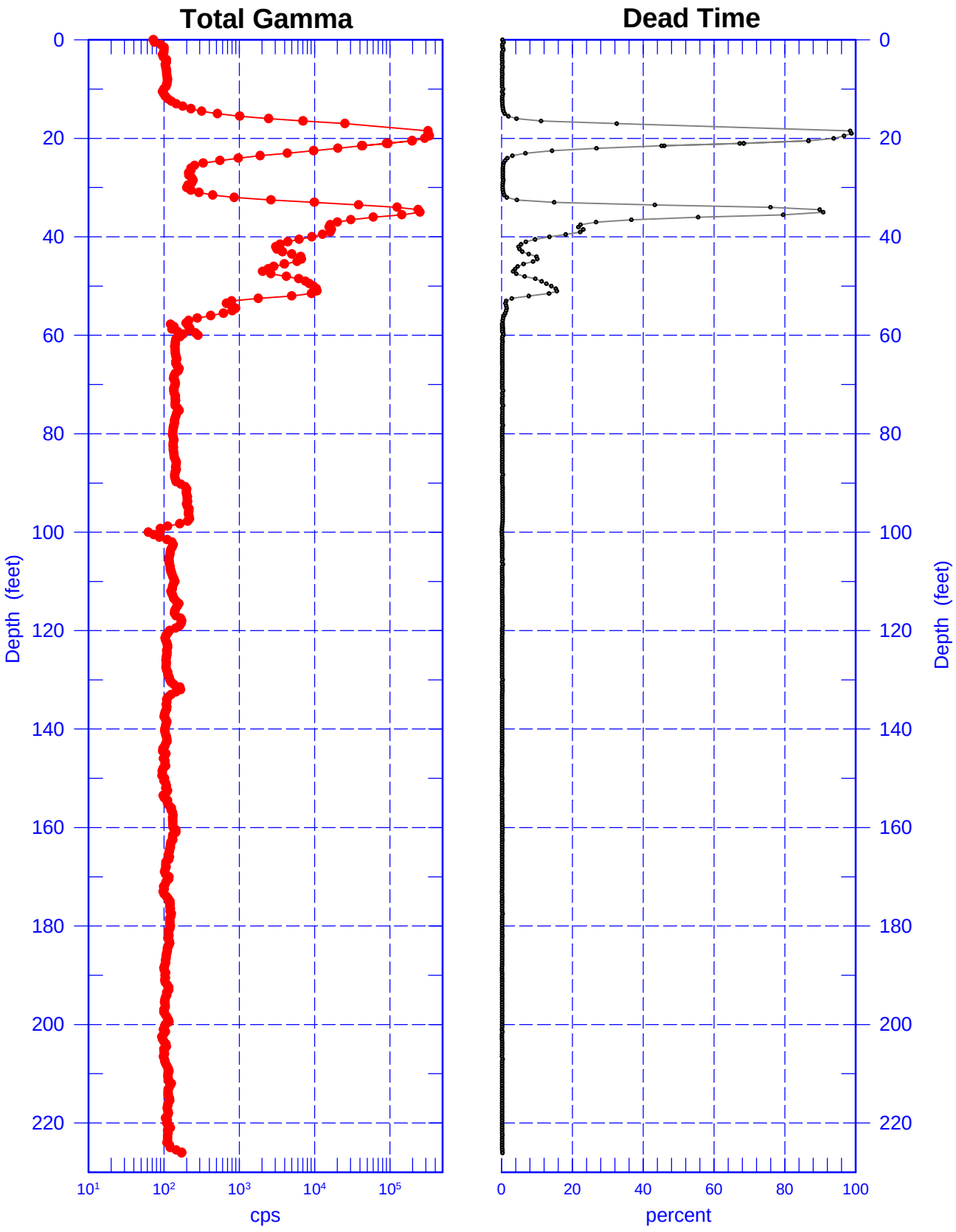
Total Gamma
Dead Time
Depth (feet)
0
20
40
60
80
100
120
140
160
180
200
220
10^1
10^2
10^3
10^4
10^5
cps
0
20
40
60
80
100
percent

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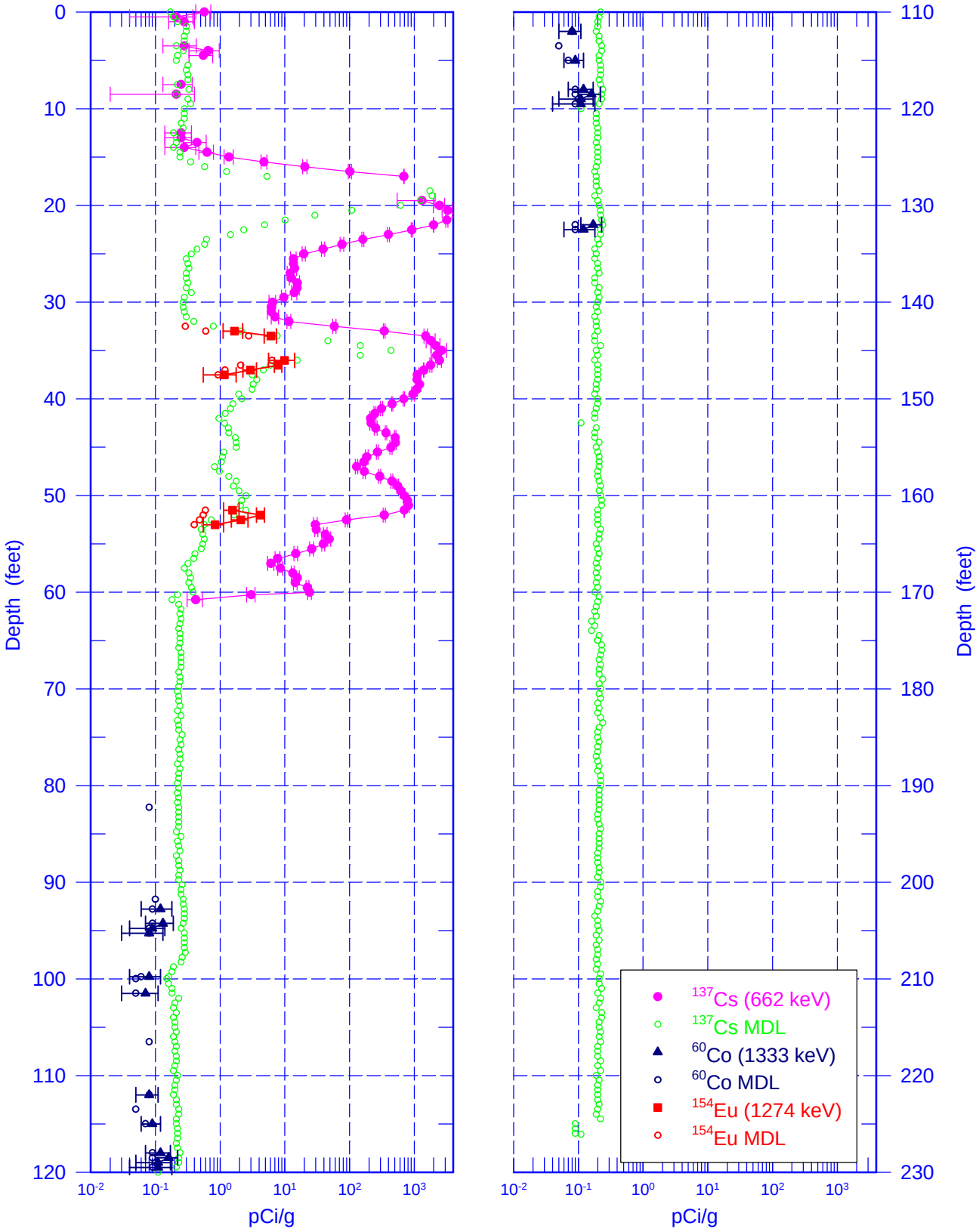
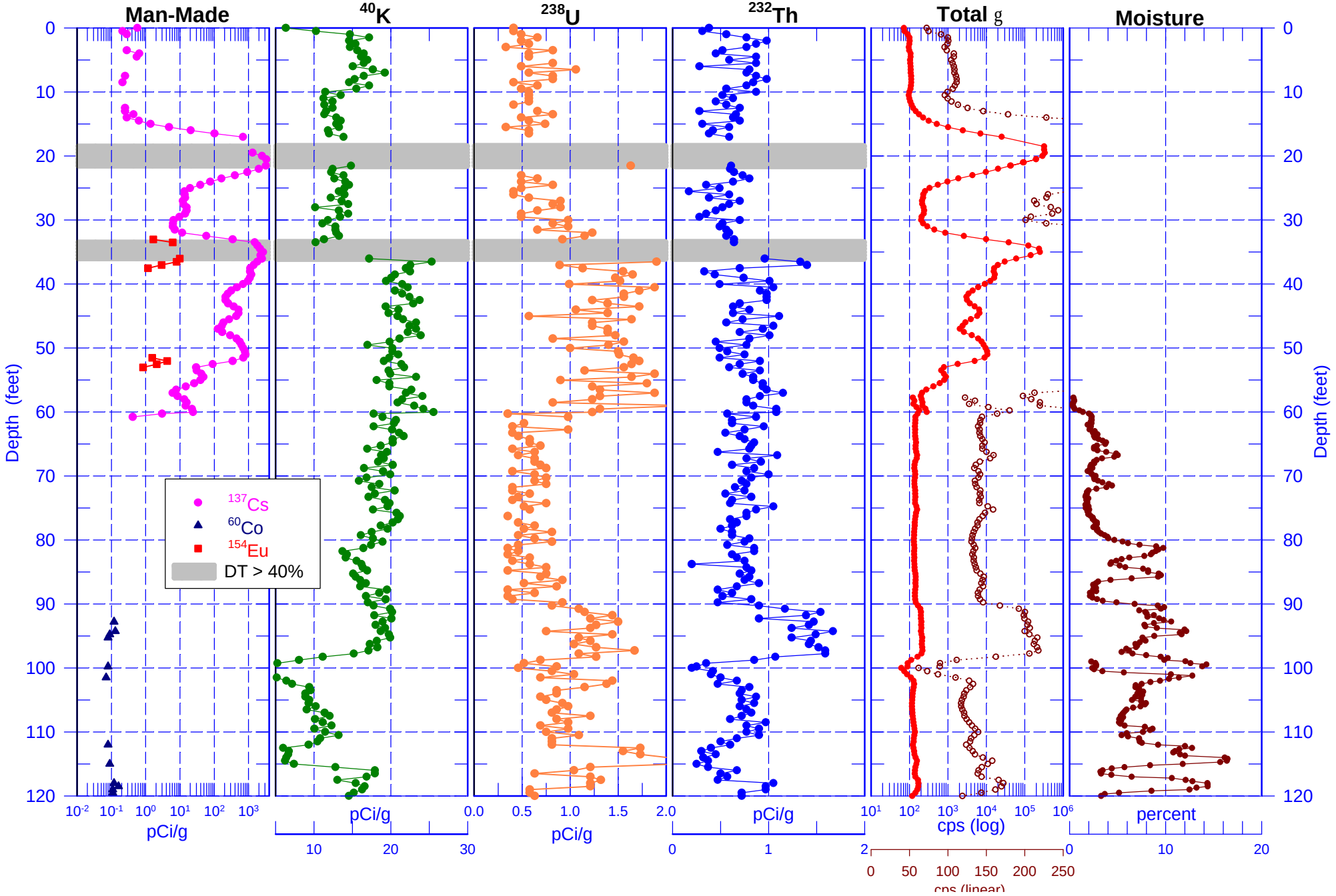
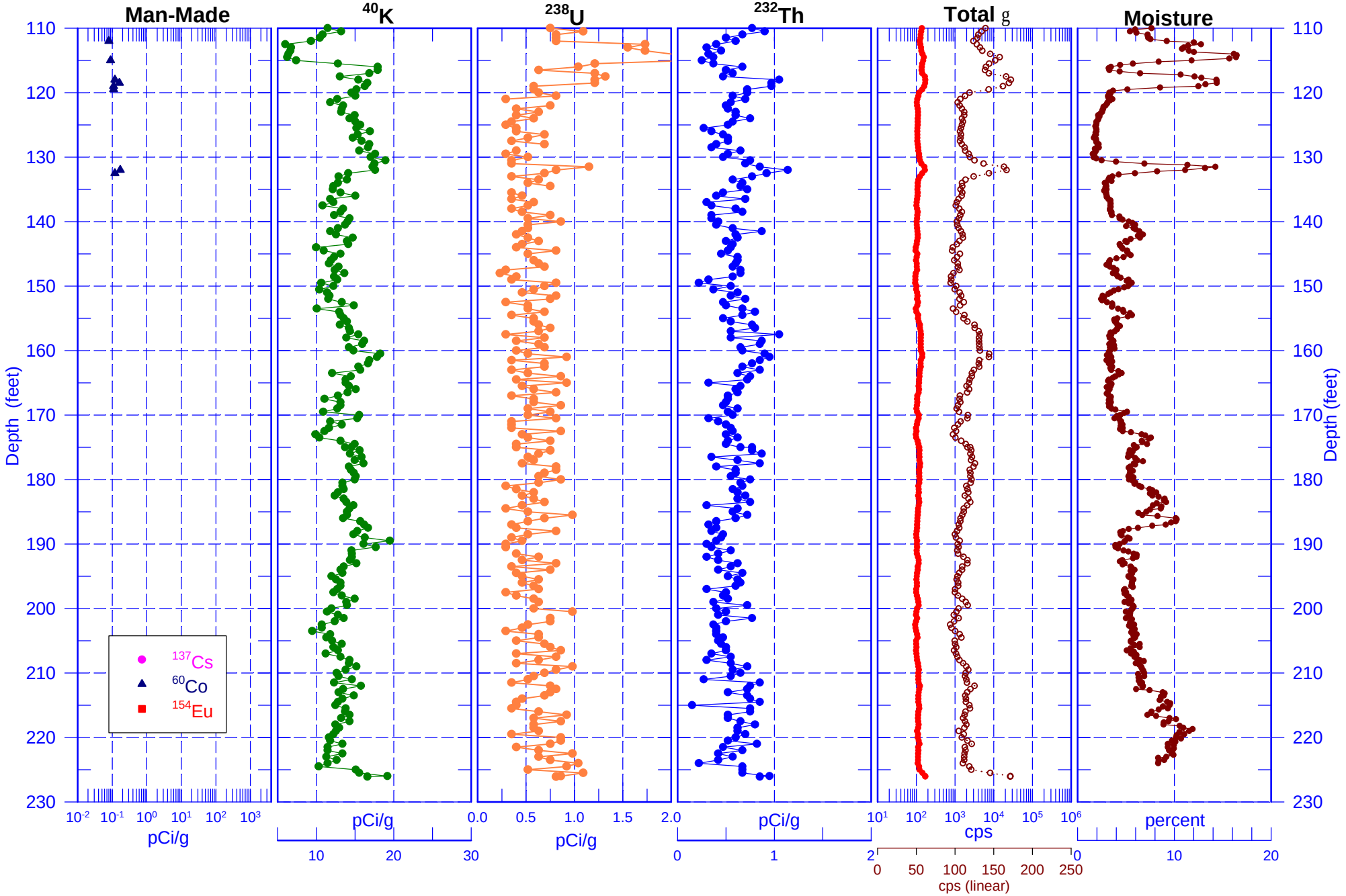
Man-Made Radionuclide Concentrations



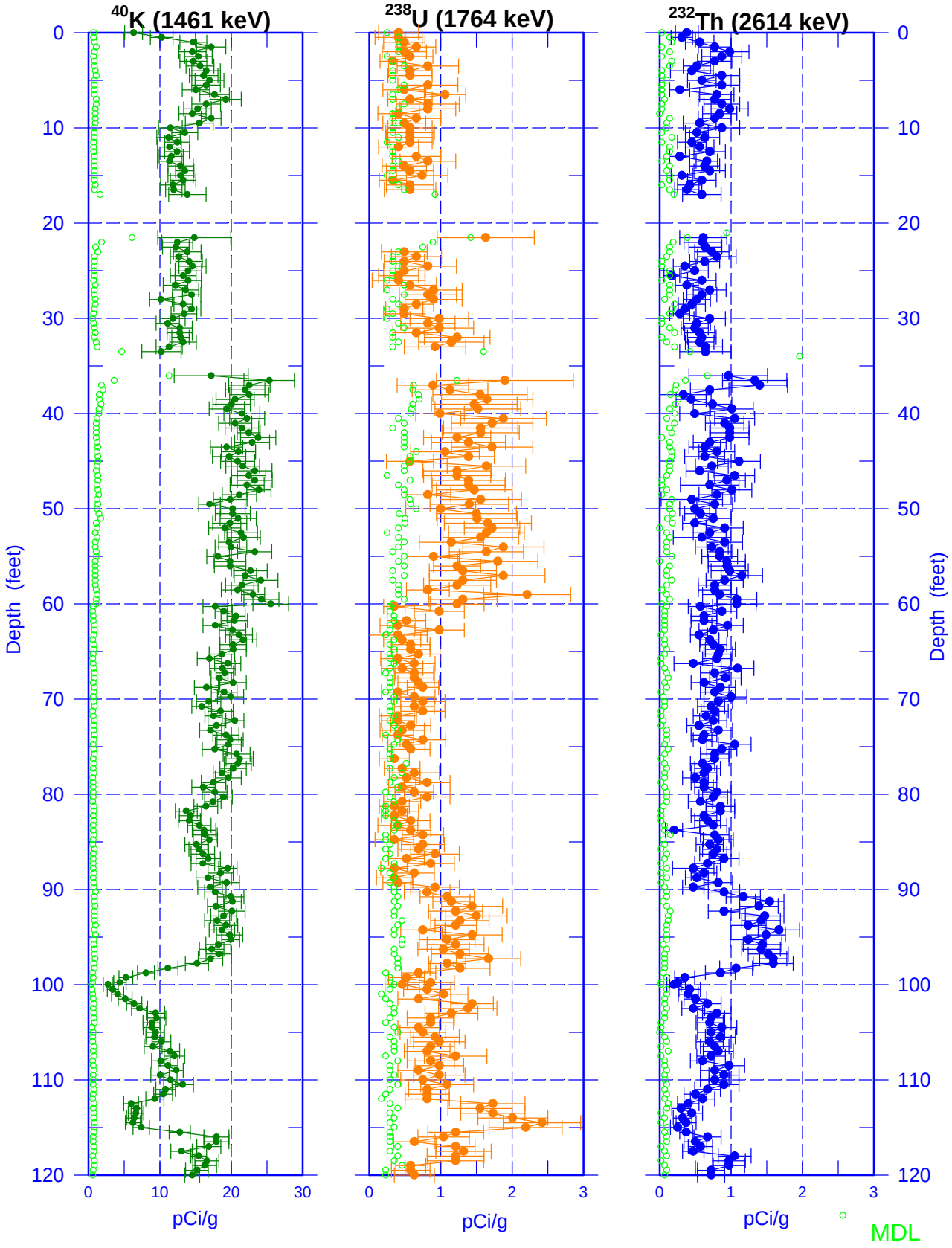
C3102 Combination Plot



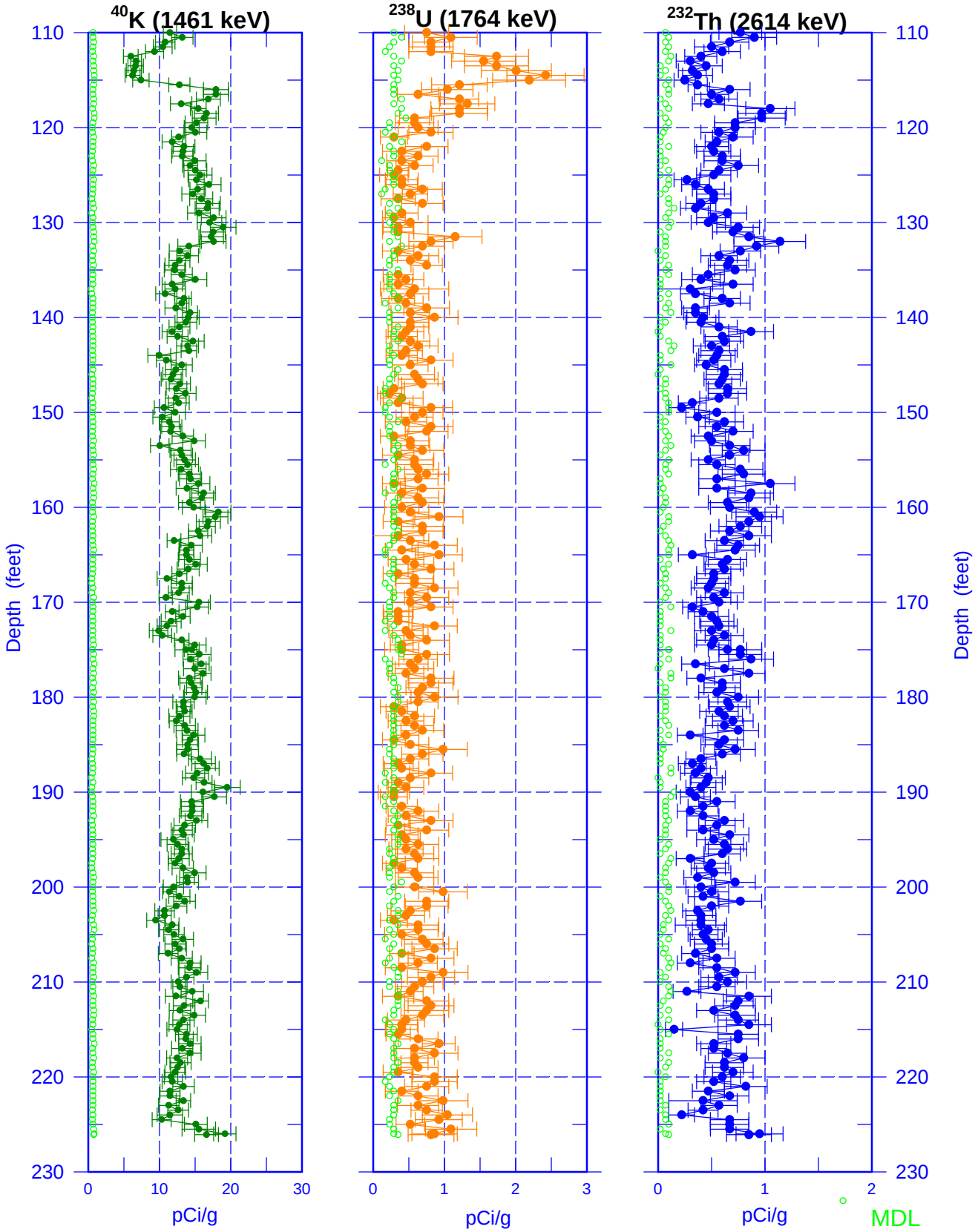
C3102 Combination Plot



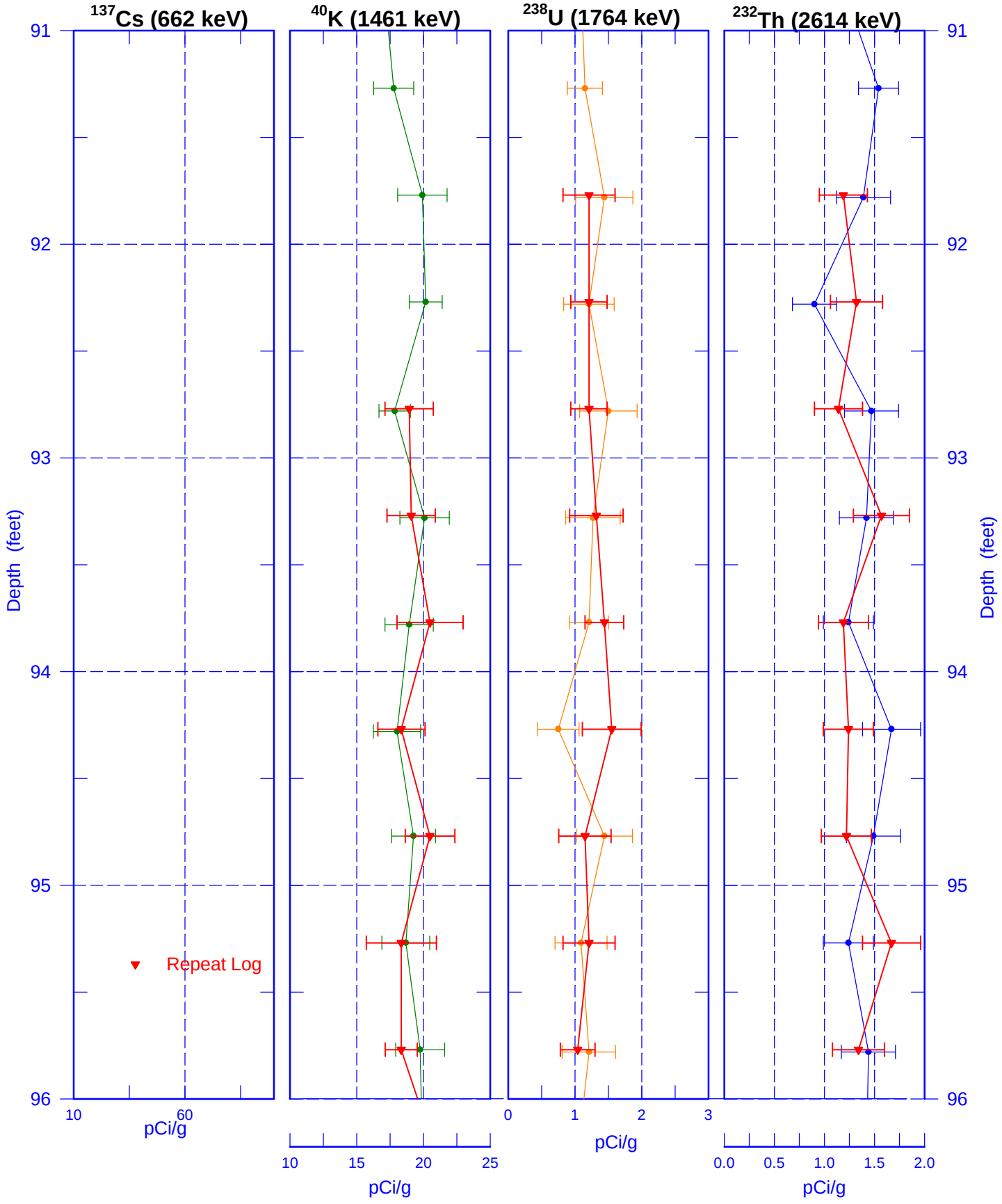
C3102
Natural Gamma Logs



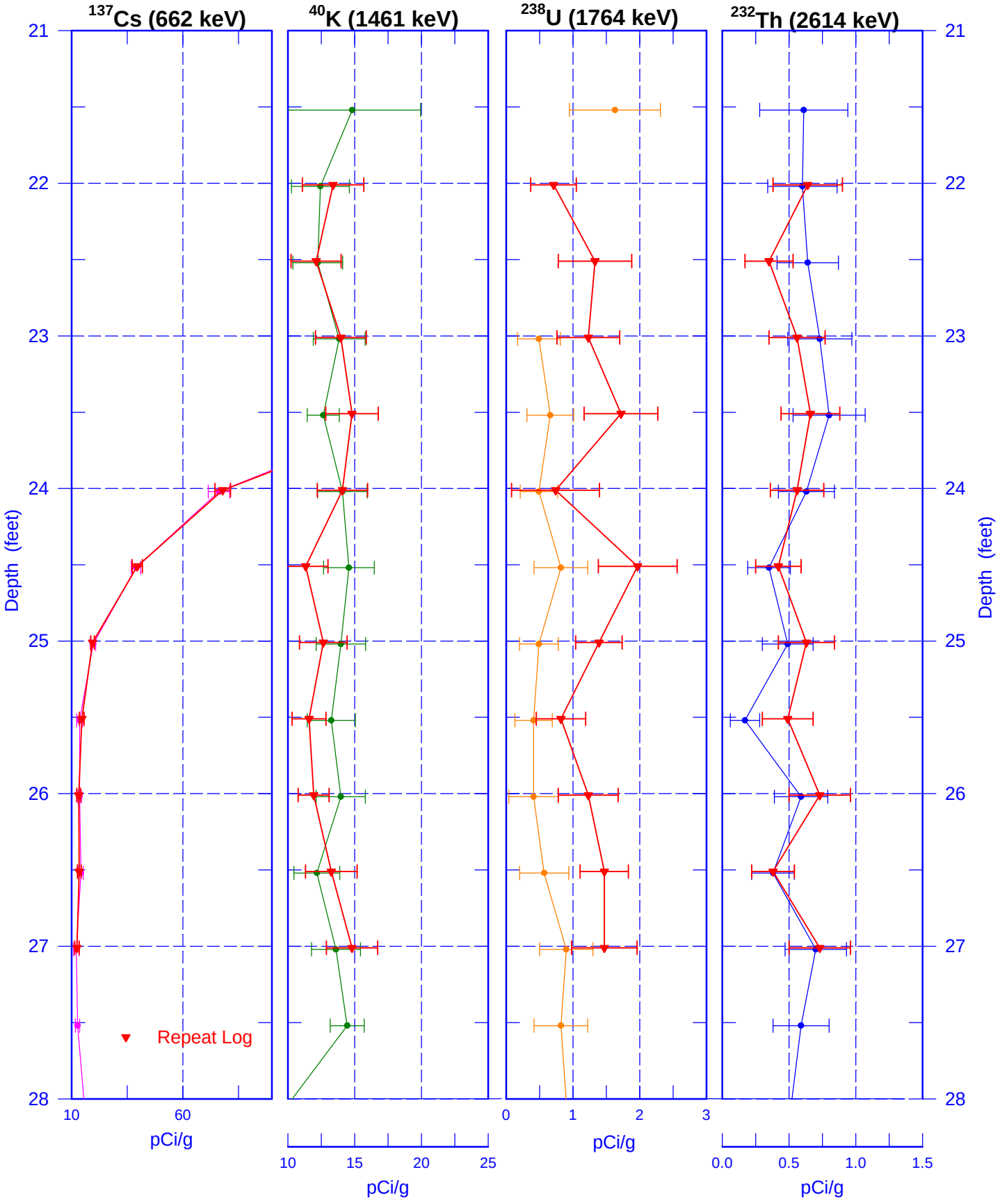
C3102
Natural Gamma Logs



C3102
Repeat Logs



C3102
Repeat Logs



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Volumetric Moisture Repeat Logs